DIMENSIONS NBS

The magazine of the National Bureau of Standards U.S. Department of Commerce

June 1979

TOXIC CHEMICALS AND THE ENVIRONMENT. See page 8.

COMMENT

ENERGY-RELATED INVENTIONS PROGRAM

Energy in all its varying forms is probably our most important resource. It heats our homes, lights our streets, and gets us to our jobs each day. The aim of the NBS Office of Energy-Related Inventions (OERI) is to find new and better ways to use energy. As part of a Department of Energy program to stimulate innovation in the small business sector, OERI tries to ensure that good energy-related inventions do not go unused for lack of development and marketing support.

After four years of operation, the NBS/DOE Inventions Program has reached a steady-state condition. NBS receives about 200 to 300 requests each month to evaluate non-nuclear energy-related inventions. Of these, two to four per month are recommended by OERI on the basis of energy-saving potential, and subsequently awarded grants by DOE. The grants, averaging $70 000 per invention, are used for market studies, development, and in some cases further research. Recently, the program reached a milestone in its operation when we recommended the 100th invention for funding. (See page 16 of this issue of DIMENSIONS/NBS.)

While this level of funding is low in comparison to other efforts to stimulate innovation, the approach is very direct and sharply focused; some $250 000 a month in DOE funding is being given to small businesses to bring new energy-saving products into the marketplace.

In the evaluation process, the role of the OERI staff evaluator is of course critical. Inventions submitted represent almost every conceivable area of non-nuclear energy technology. Although selected on the basis of exceptional technical competence and practical experience in the private sector, the eight OERI evaluators are not expected to provide expertise in each of the technologies under review. Expertise is provided as required by seven contracting firms and some 300 individual consultants. The OERI evaluators perform a "gate-keeping" function, assembling whatever information is necessary and deciding what inventions should go forward.

Three elements of the evaluation process have proved particularly important: 1) use of multiple independent expert reviews; 2) reliance on dialogue between evaluator and inventor; and 3) an open-door policy which permits submitting new information or reopening the evaluation at any time. Conflicting opinions by contractual evaluators about the same invention have been frequent. Few inventions have been recommended without evaluator contact with the inventor and submission of additional information. Of the first 100 inventions recommended, 12 were originally rejected by the process. In these cases, the evaluation was reopened when the inventor submitted new information to better describe his invention and substantiate his claims.

The NBS/DOE Inventions Program operation adds significantly to NBS skills and capability. OERI evaluators deal on a daily basis with a broad spectrum of technical professionals, many of them principals in small firms who are looking for decisions or information that will strongly affect their company's development or marketing strategies. The program is building a reservoir of knowledge about the current state-of-the-art in a great variety of technologies. This resource is certain to be of increasing value to NBS in general.

Of course, the main purpose of the program is to get promising inventions into use. Already many have been funded. (See page 19.) And although we may never discover a modern-day Edison, the program should make significant contributions to the efficient use of our Nation's precious energy.

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Cities in Renaissance

Steps toward economical building rehabilitation

by Gail Lupton

Faced with the deterioration of downtown areas, many urban renewal offices used to adopt the philosophy, "razing to the rescue." As a result, whole sections of cities were leveled, leaving low income families homeless and vacant lots in place of history.

Today, with rising costs and an increased demand for housing from the "baby boom" generation of Americans, the need for recycling rather than razing such rundown areas has increased sharply. But the same problems which encouraged demoli-

Lupton is a staff writer for DIMENSIONS/NBS.

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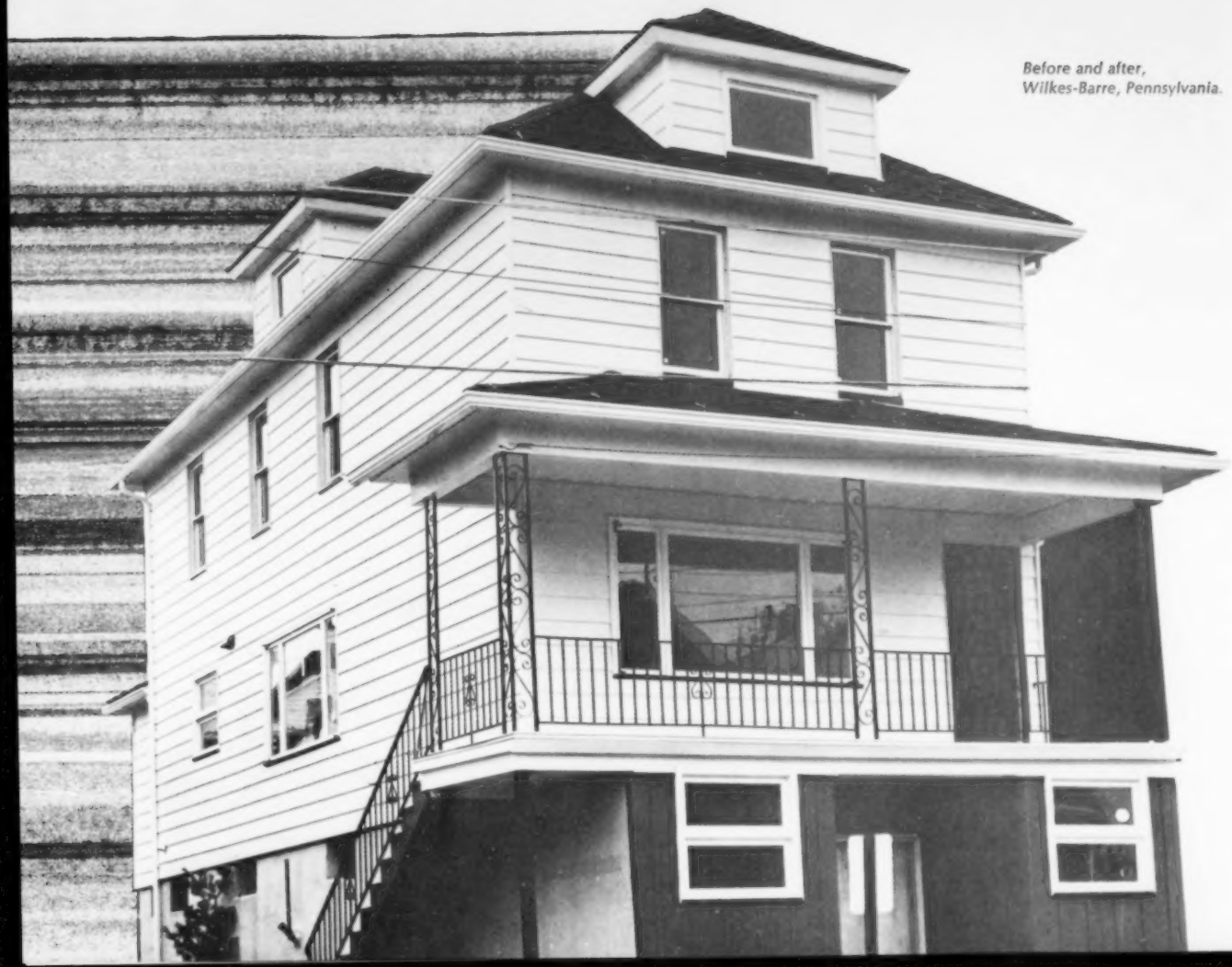

Before and after, Wilkes-Barre, Pennsylvania.

tion over rebuilding in the urban renewal programs of the 1960's are still plaguing the reuse of older buildings today. Not enough is known about the process and problems of rebuilding or rehabilitating existing buildings to make these projects appealing to large investors. And until large investors become interested, it is unlikely that large-scale rehabilitation of deteriorated areas will be possible.

At the National Bureau of Standards, researchers in the Center for Building Technology are conducting studies to help make the reuse of existing buildings easier and less costly. The goal of the Bureau's program, established in October, 1978, is to make improvements in three areas related to building rehabilitation: building regulations and the regulatory process as they affect rehabilitation, development of new technologies and methods of evaluating existing buildings, and economic tools for making sound investment and financing decisions about rehabilitation projects.

Regulations and the Regulatory Process

Current building codes are designed and written for new construction and act as a major obstacle when applied to the rehabilitation of existing buildings, says James Pielert, group leader of the NBS Building Rehabilitation Technology Program. These codes do not address the special problems of building rehabilitation such as outdated types of construction or materials. In addition, the codes for new construction may place limitations on innovative methods of repair.

Testifying before the Senate Committee on Banking, Housing, and Urban Affairs on the "Impact of Building Codes on Housing Rehabilitation" in March 1978, Boston architect Frederick Stahl described current codes as "triumphantly resistant to logical analysis . . . frustrating, costly, and time consuming at best for the professional," while "invariably inaccessible and incomprehensible for the consumer."

One particularly annoying provision in current codes is the "25-to-50 percent rule." Widely used by State and local building departments across the country, this rule dictates that the extent of a building's conformance with the requirements of the local new construction building codes should increase in relation to the dollar amount of rehabilitation planned.

In practice, this means that if rehabilitation costs are within the range of 25 to 50 percent of the value of an existing building, any improvements added to the structure must satisfy the building code for new construction. If costs exceed 50 percent of the current value, the entire building must meet the requirements of the code.

"We have many multifamily, mainly three-family, houses in Boston whose assessments—these are wooden three-deckers typically—may be as low as $6,000," said Stahl in his testimony. "I think you can see any kind of alteration would readily exceed 50 percent of that value."

Studies of the regulatory process for existing buildings began in early 1978 when NBS conducted a survey to determine the needs of code developing and enforcing organizations. NBS identified needs in the areas of code content, technical issues that should be addressed, and the impact of the regulatory process.

Later in that year, these NBS efforts resulted in an invitation to participate in a project for the State of Massachusetts, long a front-runner in building rehabilitation. Officials in Massachusetts were interested in modifying their code. A uniform system was needed which the design professional, building owner, and State and local enforcement officials could use to evaluate proposed changes to existing buildings.

Other organizations participating included the National Conference of States on Building Codes and Standards (NCSBCS), Building Officials and

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Rehabilitation project, Brooklyn, New York.

Current building codes are designed for new construction and act as a major obstacle when applied to the rehabilitation of existing buildings.

MANUALS FOR EVALUATION

Components	Attributes: Strength and stability	Health and sanitation	Accident Safety	Fire Safety	Energy Conservation	Security	Others
Structure							
Enclosure and Space							
Mechanical (HVAC, elevators, etc.)							
Plumbing							
Electrical distribution, lighting, communication							

Homestead housing, Baltimore, Maryland.

Code Administrators, Inc. (BOCA), International Conference of Building Officials (ICBO), Southern Building Code Congress International (SBCCI), Association of Major City Building Officials (AMCBO), and the National Association of Housing and Redevelopment Officials (NAHRO).

Former Massachusetts Governor Michael S. Dukakis asked these organizations to come up with interim code provisions for his State. Their combined efforts produced a document, adopted by the Massachusetts State Building Code Commission, that offers a new approach to building rehabilitation regulation.

The approach focuses on performance rather than detailed design requirements. A performance code states the minimum condition of safety and sanitation which must be met, but does not specify the methods for achieving this level of performance. Prescriptive regulations, on the other hand, may require that certain methods of construction and types of materials be used; they may stipulate minimum dimensions for stairways, doorways, window size, and so on.

"Basically," says Pielert, "the revised Massachusetts code eliminates the 25-to-50 percent rule. Instead, for buildings which can be occupied at the time of rehabilitation, the revisions allow any amount of rebuilding as long as the structure is improved. However, compliance with the code for new construction is still required for additions and certain changes in use."

"Massachusetts is the first State to adopt such code provisions," adds Pielert, "so there is a lot of interest in how they will work."

But in order for the Massachusetts code revisions to be fully successful, technical research is still needed to increase the confidence level and cost effectiveness of building rehabilitation.

Technology and Evaluation Needs

Since older structures are often made of outdated materials, building officials and designers need historical data on the materials used 50, 75, or even 100 years ago. In addition, they need ways of evaluating the structural soundness of walls, floors, and roofs, as well as methods for testing the integrity of plumbing, electrical systems, and mechanical apparatus such as heating systems.

The NBS Rehabilitation Technology Group is currently preparing technical manuals to provide guidelines for building officials and designers. (See chart of proposed manuals.) These manuals will describe test methods for evaluation of existing construction, methods of analysis to predict performance, and field inspection and evaluation methods, and will give technical data on the performance of outdated systems.

Engineer Frank Lerchen, a project leader in the NBS Building Rehabilitation Group, is working on a manual for strength and stability of existing buildings which is due to be completed later this year. This manual will include a practical discussion of methods for evaluating structural aspects of building systems and components.

For example, a discussion will be included on the use of ultrasonics (or high frequency sound waves) for locating surface and internal flaws in metals. Other topics include the use of microwave absorption techniques to determine the moisture content of concrete, the use of gun-driven steel probes for determining the strength of masonry, eddy current* evaluation techniques for locating internal flaws in steel, and neutron activation analysis** techniques for evaluating the cement content of concrete. Although these test techniques may be unfamiliar to the building community, many of them involve portable instruments which can be easily used at the building site.

Outlines are also being prepared of technical manuals that will deal with health and sanitation, accident safety, energy conservation, and solar retrofitting of existing buildings. A side benefit of developing these manuals has been the identification of additional research needs.

* *Circular electrical currents caused by material flaws.*

** *Using radioactivity to determine chemical composition of materials.*

Eliminating Guesswork about Costs

One of the most hair-pulling problems of building rehabilitation is the difficulty that builders have in estimating costs. The pricetags associated with rehabilitation projects are frequently underestimated because expensive problems may not be obvious at the outset. In the process of removing a wall for remodeling, for example, pipes may be dislodged and require repairs. What seems at first to be an adequate electrical system may actually need extensive repairs when examined closely.

Economist Robert Chapman of the Applied Economics Group at NBS has compiled information about the current state-of-the-art for estimating rehabilitation costs. What is missing in the predictive computer models currently in use, says Chapman, is some means of measuring the financial risk involved with a particular project.

By developing probability scenarios of a builder's most favorable, most likely, and most unfavorable cost requirements depending on the type of project and specific characteristics of the building, Chapman says he will be able to develop a model to tell the builder how such expenses can be expected to vary.

Eventually, he says, the Applied Economics Group hopes to be able to design a cost-estimation equation that will take much of the guesswork out of rehabilitation financing.

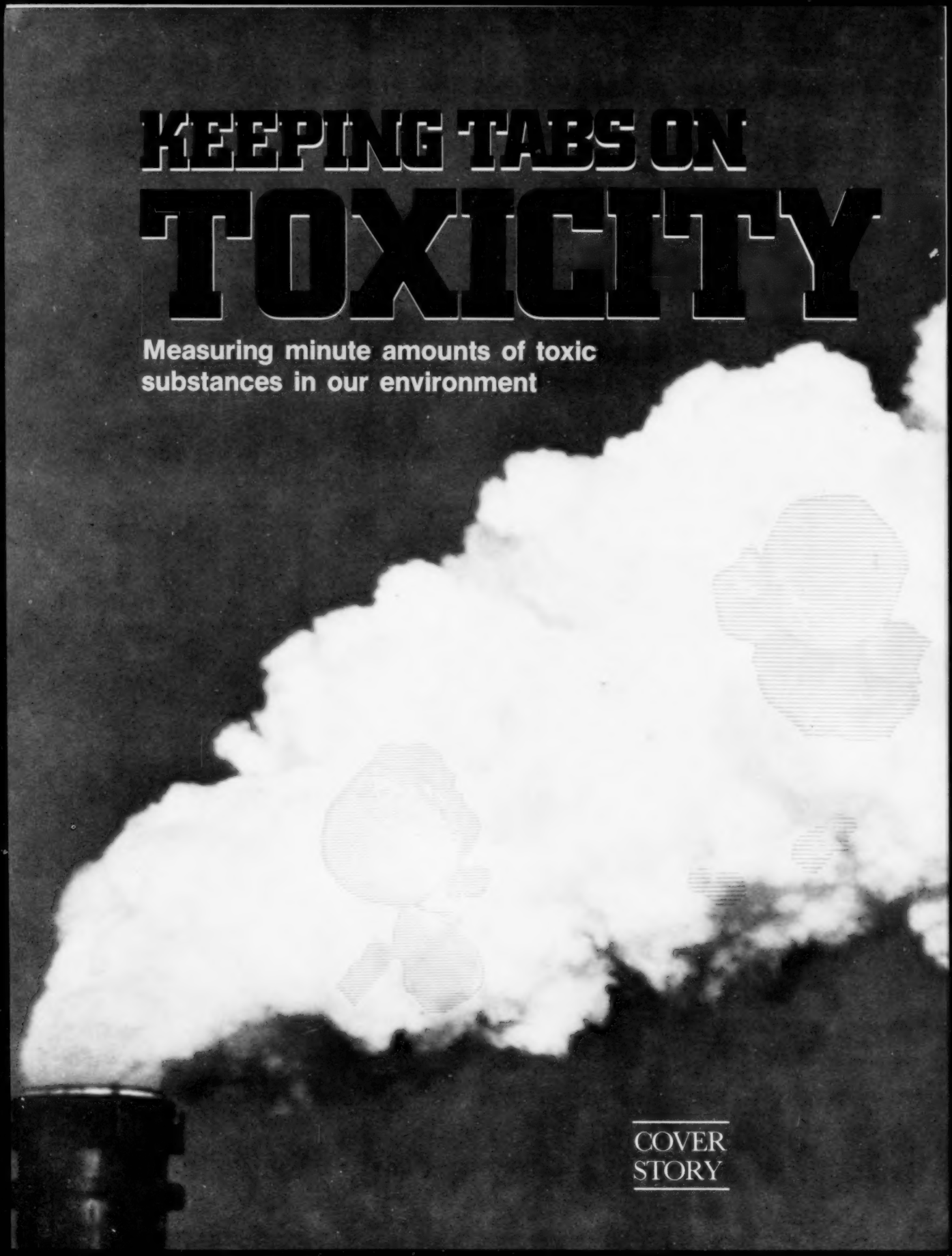
In the meantime, many major U.S. cities, including St. Louis, Boston, Baltimore, and Washington, D.C., have completed successful rehabilitation projects.

However, much remains to be done. In March 1979, for instance, Washington, D.C., Mayor Marion Barry announced, a $35 million plan to rehabilitate deteriorated Washington residential neighborhoods. He was quoted in the *Washington Post* as saying, "To provide housing for all who need it, we need help from the Federal Government in a massive way . . . The housing crisis can't be solved by the D.C. Government alone."

By working with other organizations to help develop a technically sound basis for regulations and an improved regulatory process and by providing more accurate techniques for building evaluation and cost estimation, the NBS Center for Building Technology hopes to make a substantial contribution to the efficiency and ease with which buildings can be rehabilitated.

If the effort is successful, there will be more homes for more people and hopefully a healthier outlook for the Nation's cities. □

One of the most hair-pulling problems of building rehabilitation is the difficulty builders have in estimating costs.



KEEPING TABS ON TOXICITY

Measuring minute amounts of toxic substances in our environment

COVER STORY

by Mat Heyman

Much like poor Alice, those working to clean up and protect our environment must sometimes feel they are running faster and faster just to keep up. Where they can point to visible progress in combatting the most obvious forms of pollution, each new gain seems

Heyman is a writer and public information specialist in the NBS Public Information Division.

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to be offset by more distressing news of a largely invisible, potentially more destructive group of pollutants, namely toxic substances.

Tracking down toxic chemicals that are present in our environment only in "trace" amounts—sometimes in the parts-per-billion range—is a difficult enough task. Finding ways to measure the amounts of these hazardous pollutants to a high degree of accuracy puts our most sophisticated measurement methods and equipment to an even tougher test.

As part of a decade-long effort to supply improved measurement techniques and standards necessary for safeguarding the Nation's environmental quality, NBS research is providing some of the underlying measurement information and innovations that will be necessary in coping with toxic materials.

Already, the NBS environmental measurement program has led to the development, production, and distribution of more than 75 Standard Reference Materials (SRM's) for use in environmental chemical analysis.* Coordinated through the Office of Environmental Measurements, this combination of SRM's and other environmental research activities at the Bureau offers the Nation's researchers and pollution abatement experts the tools to ensure reliability in measurement and to facilitate advances in areas of science and technology.

Scientists in two NBS groups provided one such tool when they developed a new technique for standardizing measurements of a class of materials called polynuclear aromatic hydrocarbons (PAH's). These compounds are of special interest to environmental and energy researchers since many PAH's have been demonstrated to be carcinogenic. Naturally occurring in fossil fuels, PAH's are closely associated with several important energy technologies, including petroleum and shale oil production and coal liquefaction and gasification. Their special threat to our water resources is linked directly to the nature of those technologies. PAH's may be introduced into the marine environment via oil spills during drilling operations or tanker mishaps. They also may find their way into water in the aqueous effluent from coal liquefaction and gasification operations.

In order to measure accurately the concentrations of PAH's found in any single water source, laboratories need an SRM for comparison. But measurement of PAH's poses special problems. First, their low solubility in water makes it impossible to use

** SRM's are well characterized materials or measuring devices which have one or more physical or chemical properties certified by NBS. SRM's are widely used for calibrating or testing all kinds of measuring instruments.*

the more traditional techniques for preparing accurate chemical measurement standards. In conventional standards, known quantities of the chemicals to be measured are typically dissolved in a solution, which is then analyzed and can be packaged for use in calibrating laboratory equipment, evaluating samples, or performing research. But when PAH's are placed in water, they tend to adsorb onto the walls of storage vessels and tubing of the laboratory equipment. Moreover, since they are carcinogenic, they are dangerous to handle. This means that special care needs to be taken in working with these chemicals so that they do not enter the laboratory environment.

Scientists in the NBS Center for Analytical Chemistry and the Center for Thermodynamics and Molecular Science last year discovered a way to overcome these difficulties. Glass beads coated with PAH's were packed in short stainless steel tubes. Saturated solutions of PAH's were first generated by pumping water through a tube and were then analyzed, enabling NBS to certify the stainless steel tube and its contents as a new SRM. By confining the PAH's within the tube, environmental contamination and exposure of the laboratory analyst to carcinogenic chemicals is minimized.

The full significance of this development goes far beyond the provision of an SRM for polynuclear aromatic hydrocarbons. As part of the Bureau's work in a special national program of research about the environmental implications of energy production and use, this technique now opens the door to the generation of SRM's for the whole range of toxic organic chemicals found in water. For instance, the method also may be applicable to the measurement of pesticide compounds that are otherwise difficult or impossible to measure.

Also in the quest to provide more precise measurement of environmental contaminants in water, NBS last year developed SRM 1643, Trace Elements in Water. This SRM is already helping State environmental and public health scientists to evaluate the accuracy of trace element measurements in filtered and acidified fresh water. It also is useful for calibrating instrumentation used in making these determinations. The SRM was prepared by using high purity water and 23 elements to simulate the elemental composition of natural fresh water. The Environmental Protection Agency (EPA) has set maximum contaminant levels for a number of the elements contained in the SRM under authority provided by the Safe Drinking Water Act enacted in 1974.

The potential for using new electrochemical

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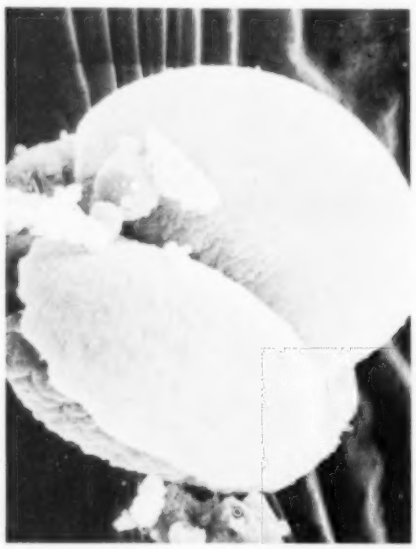
NBS measurement capabilities are relied upon for a variety of environmental research and regulatory activities. Shown below, magnified by a scanning electron microscope, are urban air particulate and asbestos fiber samples.



techniques to reveal in more detail how toxic chemicals travel through our environment was vividly demonstrated last year in the Center for Analytical Chemistry. Bureau scientists working in cooperation with the University of Maryland coupled two traditional yet separate techniques used by chemists—liquid chromatography and differential pulse electrochemical detection—to identify and measure methylmercury, a toxic organometallic substance. Conventional analytical methods can be used to measure the total mercury content in an environmental sample, but it is the organometallic mercury species which are deemed most harmful. This NBS-applied hybrid technique allows laboratory researchers to determine selectively the toxic forms of mercury. Bureau scientists have used this method to measure the methylmercury levels in tuna, shark meat, and oyster tissue.

On Land, in the Air

The Bureau's environmental research and measurement programs also address the problems of pollutants on land and in the atmosphere. For example, the Center for Materials Science has devised a new method to separate and measure individual organic derivatives of tin and arsenic at trace concentrations in soil as well as in water. These derivatives often are contained in herbicides, antifoulants (like those used to slow the growth of barnacles on hulls of ships), and a variety of pesticides. By combining traditional chemical separation and detection techniques—liquid chromatography with graphite furnace atomic absorption or with an ultraviolet detection technique—NBS researchers demonstrated a vastly improved method for analyzing metal-based biocides in the environment.

This Bureau innovation permits the measurement and characterization of individual elements in the parts-per-billion range and provides greater sensitivity than conventional measurement methods. It also allows quicker evaluations and does less damage to the sample being analyzed, which means that the sample can be used again for other tests. With this method, researchers can follow the progress of these materials as they degrade, are transported, and concentrate in parts of the environment. They can also observe the transformation of what may be a relatively harmless herbicide, for instance, into a toxic or carcinogenic form.

The first phase of another Bureau project important for safeguarding both land and water resources was completed when NBS researchers developed test procedures which can be used to compare recycled oils with "new" (virgin) oils. This effort by the Office of Recycled Materials will encourage the reuse of once-used oil which would otherwise be wasted or possibly become a serious environmental hazard if dumped into sewers, rivers, or landfills. The NBS test procedures were called for in the Energy Policy and Conservation Act enacted in 1975 and are to be used to establish the "substantial equivalency" of recycled oil with virgin oil for each potential end use. The Bureau's test procedures are being provided to the Federal Trade Commission, which will then remove certain restrictive labeling requirements for recycled oils that can pass the tests. This should enable recycled oils to compete more effectively with virgin oils in the marketplace.

The Bureau's measurement capabilities are also applied in controlling air pollution from automobile exhausts and achieving Federal clean air standards. And since auto fuel economy ratings are calculated on the basis of exhaust gas measurements, NBS measurement skills are also important in this facet of Federal automobile standards concern. Along these lines, several advancements in auto exhaust analysis were made recently at the Bureau, which has been providing SRM's and performing research in both automobile fuel economy and pollution measurements for a number of years. Through an agreement signed last year, the Bureau is assisted in its development and production of SRM's in this area by a two-year Research Associate Program sponsored by the Motor Vehicle Manufacturers Association. The program aims to develop and produce 26 new gas SRM's for use in establishing the accuracy of motor vehicle emissions tests, with primary emphasis on measurement of emissions from heavy duty engines.

An automated gas analysis system for the certification of primary gas mixture SRM's was developed last year in a project cosponsored by NBS and EPA. Termed COGAS, for computer-operated gas analysis system, the arrangement is designed to sequentially sample and analyze up to 25 cylinders of a given

Left. *The engine exhaust from a new automobile is measured at the EPA Emission Testing Facility at Ann Arbor, Michigan.*

Below left. *Research chemist Ernest Hughes (standing) and research associate Robert Miller prepare to analyze a batch of gaseous standard reference materials using a computer-operated gas analysis system.*

gas mixture without supervision. COGAS has permitted a substantial reduction in the costs associated with SRM certification, while also producing a larger, more precise data base upon which the absolute gas concentration is derived. With slight modification, the system can be used by other Federal agencies, State Governments, and motor vehicle manufacturers as an instrument to significantly reduce the labor requirements in exhaust sampling and analysis.

Also in the area of auto emission testing, a long-wavelength acoustic flowmeter was invented for measuring the rate of exhaust flow from the tailpipe of an automobile or truck. Linked with pollutant concentration detectors, this flowmeter could be used on production lines and in State and local test stations to determine compliance with EPA emission regulations. There is no competing technique for measuring the exhaust flow rate and the NBS device could eventually replace conventional testing equipment, which is comparatively expensive and cumbersome. Moreover, the flowmeter

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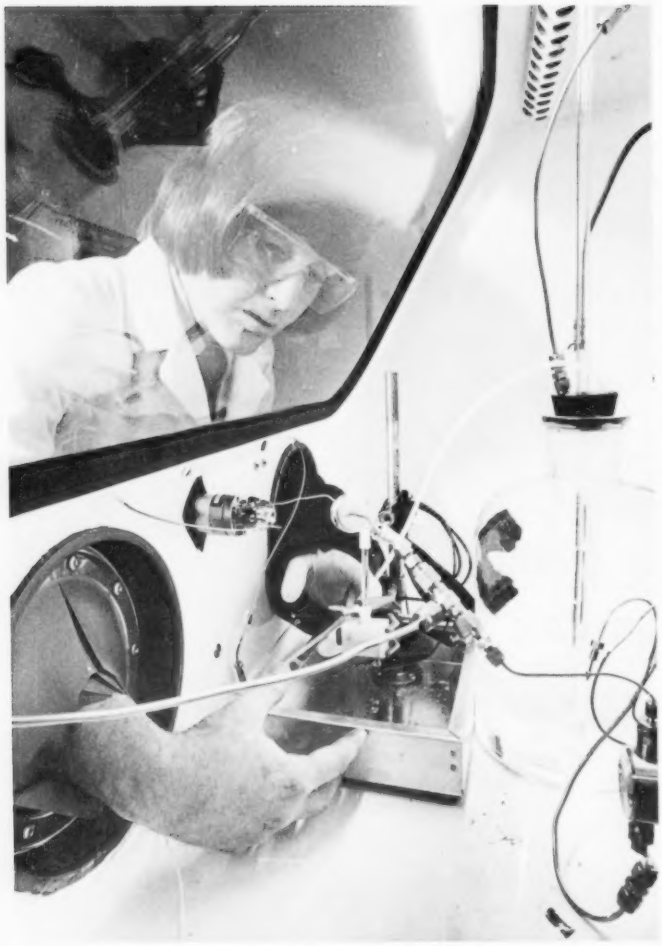

A solution of biological materials is analyzed for methylmercury concentrations by Research Chemist Bill MacCrehan. He is using an electrochemical detection cell. The process must take place in an oxygen-free atmosphere.

could provide more accurate information and be operated by unskilled personnel. Developed in the Center for Mechanical Engineering and Process Technology in cooperation with the Office of Environmental Measurements, the flowmeter may also have applications in developing fuel-efficient engines or in medical research for measuring human or animal breath flow rates.

In addition to auto-related pollution, the Bureau also addresses measurement needs associated with other sources of air pollution. For instance, NBS issued a sulfur dioxide SRM useful in measuring the pollutants from fossil fuel power plants. Along the same lines, Bureau researchers have now developed a nitrogen dioxide SRM which will be used to analyze emissions from nitric acid plants and power generation facilities.

Emissions from waste incinerators are still a significant air pollution problem, despite advances in control technology. In order to control these pollutants, engineers must know the chemical makeup of the waste material. Studies in the Center for Thermodynamics and Molecular Science led to the publication last year of thermodynamic data for 331 selected materials important to waste incineration processes. The data provide engineers with information that will help them design facilities to handle waste materials in a more effective and environmentally acceptable manner. This publication also offers engineers better measurements of the potential energy content of the waste stream for use in projects to recover heat from the incineration process. Undertaken in conjunction with a committee of the American Society of Mechanical Engineers and administered through the NBS Office of Standard Reference Data, its inclusion in the Bureau-operated standard reference data network ensures its widespread distribution and use as a carefully evaluated and accurate data source.

The Bureau also focuses on what happens in the upper levels of the atmosphere. In one project, NBS carried out basic research leading to a revision in previous estimates about possible damage to the earth's protective ozone layer posed by supersonic transport planes and by fluorocarbons from aerosol propellants and other sources. Because of the complex individual and chain interactions of various pollutants with each other and with naturally occur-

Powdered samples of shark, tuna, and oyster tissue are prepared for testing to determine concentrations of toxic organometallic mercury.

ring concentrations of atmospheric constituents, it is necessary to determine many reaction rates in order to estimate how the addition of each pollutant would affect the present quality of our atmosphere. With these reaction rates between pollutants and atmospheric constituents and between each other, the atmosphere can be accurately modeled or simulated. This model can then be utilized to estimate the effects of specific substances in the atmosphere.

As part of a joint program with the National Oceanic and Atmospheric Administration, NBS identifies and experimentally measures critical chemical reactions using laser spectroscopic techniques developed at the Bureau. Scientists in the Bureau's Center for Absolute Physical Quantities last year reported on research to determine the reaction rates when hydroperoxyl radicals—important components of the upper atmosphere—interact with nitric oxide. The NBS-NOAA research involved the direct measurement of this chemical reaction for the first time. When this information was plugged into a computer model of the upper atmosphere, it significantly altered earlier analysis of the ozone depletion problem. Accordingly, supersonic transports are now judged to have little effect on the ozone layer. In fact, at some altitudes, they may actually create ozone. As a result of this research, however, damage to the ozone layer from fluorocarbons is estimated to be three times greater than had been previously assumed.

The latest basic data used as input by all models of stratospheric pollution effects were published by the Bureau as part of the NBS program of standard reference data evaluation and dissemination. *Reaction Rate and Photochemical Data for Atmospheric Chemistry*, NBS Special Publication 513, is a compilation of over 400 critically evaluated reaction rate items. It was cosponsored by the Department of Transportation, the National Aeronautics and Space Administration and three NBS groups—the Office of Standard Reference Data, the Office of Environmental Measurements, and the Center for Thermodynamics and Molecular Science.

Like most of the Bureau's environmental research and services, this publication provides the measurement necessities for monitoring, evaluating, and improving the quality of our environment. □

Wanted: Better Energy Ideas

A Milestone for the Office of Energy-Related Inventions

by Susan Lieberman

Americans are continually looking for new and better ways of doing things. Combining this basic desire with Yankee ingenuity, one small U.S. business has developed an innovative solar collector, making it the 100th invention recommended for Government support in a unique program aimed at encouraging energy savings in the U.S.

Under this program, the Office of Energy-Related Inventions (OERI) at the National Bureau of Standards evaluates inventions and recommends those with promise to the Department of Energy (DOE) for support in development and/or marketing.

Developed and marketed by Bio-Energy Systems in Spring Glen, N.Y., the flat plate solar collector for hot water and building heating systems is comparable in efficiency to others on the market, but the costs of its construction and installation appear to be less. Its design is also unique, using a manufacturing process similar to that for making garden hoses in which the structure is produced in continuous strips and cut to a desired length. The collector is made of special black rubber (ethylene-propylene-diamine) which is resistant to temperature extremes and sunlight and has an expected lifetime of over 20 years.

OERI has recommended that DOE give financial support to install demonstration units to verify the performance and durability data supplied by Bio-Energy Systems. OERI feels that the invention should provide consumers with a cost-effective alternative to fossil-fuel-based space heating/hot water systems.

The Energy-Related Inventions Program is aimed particularly at inventions submitted by individuals and small businesses and can be a significant first step for the entrepreneur who is looking for Government support for an invention. Since the program began in mid-1975, NBS has received more than 10 000 invention evaluation requests. On the average, 3 out of every 100 inventions accepted for evaluation are expected to be recommended to DOE, which then considers the inventions for possible financial assistance.

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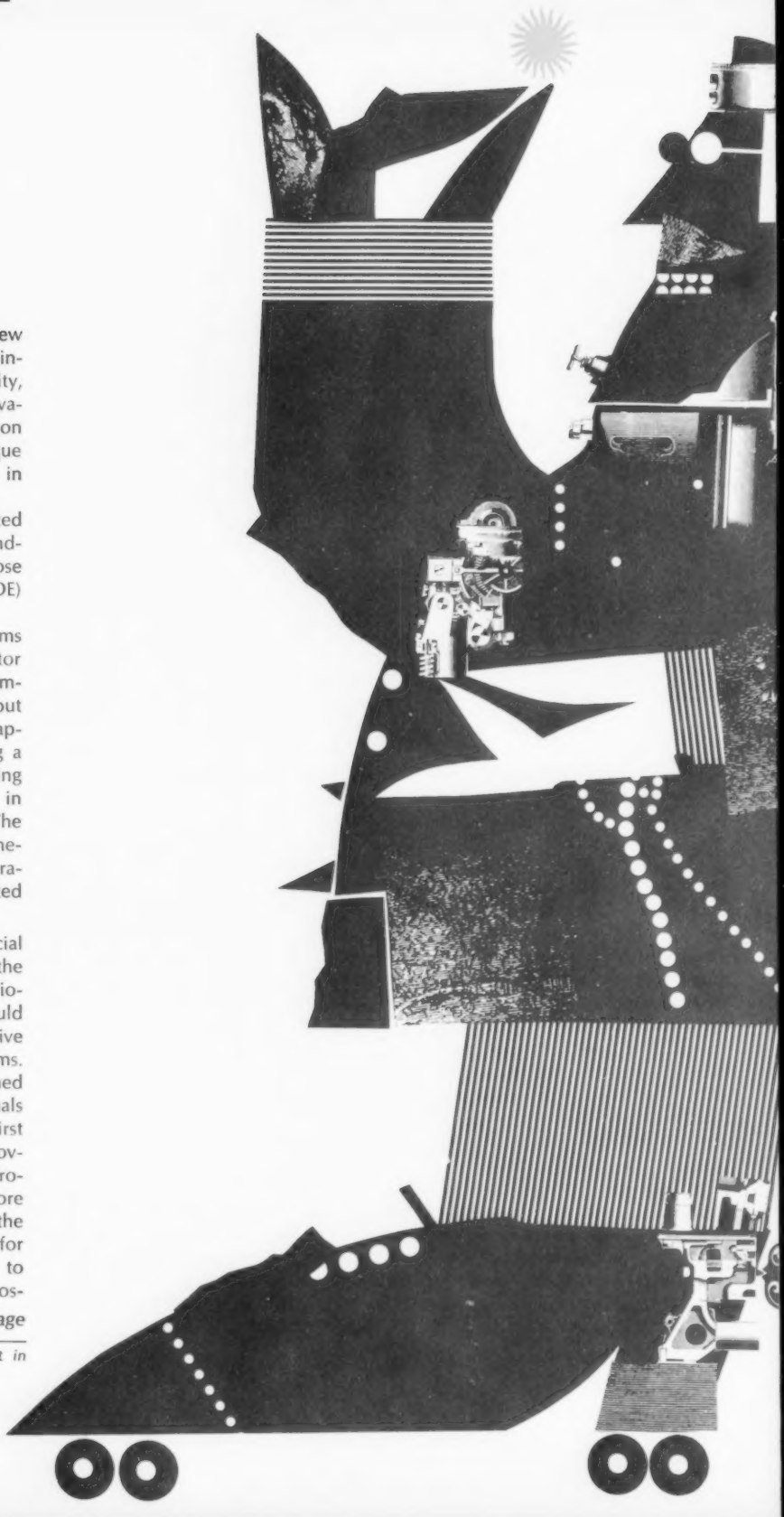
Lieberman is a writer and public information specialist in the NBS Public Information Division.



Of the 100 inventions that have been recommended by OERI, DOE has already funded 41, to the extent of almost $2 800 000. Some have industrial applications while others are designed to save energy in residences and in transportation.

A reflective-type solar collector, submitted by another inventor, has already received a grant for marketing studies from DOE. The collector, which is suitable for home use, was designed to achieve greater efficiency at higher temperatures without seasonal or daily adjustments.

Other inventions with residential applications which have been awarded grants by DOE are a water-powered food waste disposal and an insulating window shade. Supported inventions with industrial applications include instrumentation to improve quality control in steel-making and a technique for fabricating ceramic turbine rotors that will operate at high temperatures, making higher operating efficiency possible.

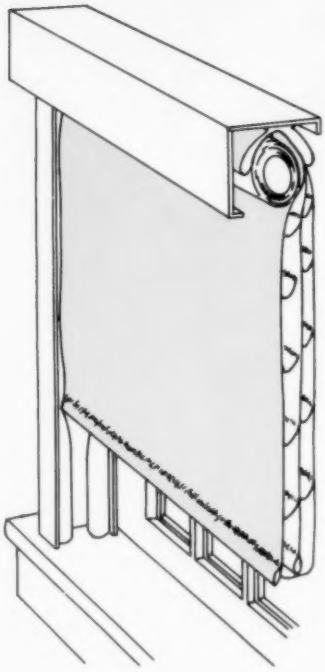
Evaluation requests received by NBS are first reviewed to make sure that the invention is nonnuclear-energy-related, that the disclosure is clear and complete, and that there are no obvious technical flaws. About half of the disclosures are found to be acceptable for evaluation. OERI then initiates a two-stage evaluation to examine both commercial and technical feasibility. The first stage consists of a series of brief independent reviews by experts in government or the private sector to identify promising inventions. In the second stage, a more in-depth analysis of the promising invention provides the justification for NBS to recommend support by DOE. OERI's evaluation staff of 8 engineers is supported in the evaluation process by 7 contracting firms and some 300 private and public sector consultants.

The proprietary rights of the inventors are protected by Government procedures that have been established for handling invention disclosures.

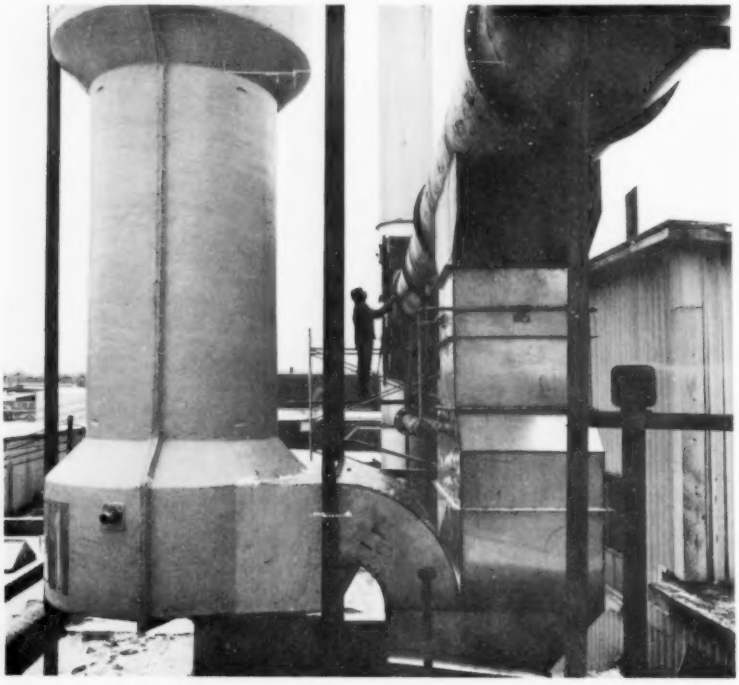
Inventors and small business companies are invited to submit their ideas to OERI for a free evaluation. For an Evaluation Request Form (NBS-1019), or additional information write to:

Office of Energy-Related Inventions
National Bureau of Standards
Washington, D.C. 20234 □

A "thermal shade" to be fitted to conventional windows and to retract into a small space.



A system for recovering waste heat from industrial combustion processes by using water in direct contact with combustion products and an auxiliary heat exchanger.



Emulating Edison

Since July 31, 1790, when the first patent was issued in the United States, over four million inventions have been patented. Some are well known: the automobile, the phonograph, the light bulb.

Since 1975, 100 inventions evaluated by the NBS Office of Energy-Related Inventions have been recommended to the Department of Energy, either for direct grants for development or marketing or for additional evaluation. As this magazine was going to press the inventors and inventions listed below had already received support under this unique Government program. Others have received grants too recently to be included, while still more are under consideration.

INDUSTRIAL

Philip Zacuto, Woodside Construction Corp., New York
A system for recovering waste heat from industrial combustion processes by using water in direct contact with combustion products and an auxiliary heat exchanger. Awarded $125 000.

G. R. Fitterer, Fitterer Engineering Assoc., Inc., Pennsylvania
A probe device and system to monitor and control the amount of oxygen present in steel making. Awarded $99 600.

William P. Boulet and Associates, Louisiana
A dryer/boiler using sugarcane waste for fuel; exhaust gases from this process are used to "pre-dry" fuel prior to entering boiler. Awarded $111 220.

Leopold Pessel, AEL-EMTEC Corp., Pennsylvania
A method of removing sulfur dioxide from flue gases by scrubbing the gases with an aqueous solution of metal salt. Awarded $94 150.

Donald C. Erickson, Energy Concepts Co., Maryland
A process for generating tonnage hydrogen from carbonaceous fuels. Awarded $80 820.

James C. Withers, Virginia
A technique for fabricating turbine rotors that will make it possible to operate at higher temperatures and efficiencies. Awarded $125 000.

Kenneth E. Mayo, Tuned Sphere International, Inc., New Hampshire
A stable ocean platform for oil drilling, production, storage and transfer. The platform's spherical hull shape and fixed and variable mechanical systems diminish or offset the motion of the ocean waves. Awarded $90 000.

Harrison R. Woolworth, Washington
Apparatus and method to extract waste heat from ingots and billets to be utilized in the preheating of scrap steel before being placed in an electric arc furnace. Awarded $170 000.

John McCallum, Ohio
A process for producing smokeless fuel, high BTU gas, and other products from coal and other carbonaceous materials using low-temperature carbonization, amalgam-type by-products, and electrochemical cells in various combinations. Awarded $49 740.

BUILDINGS

Thomas P. Hopper, Connecticut
A multi-layer window shade to be fitted to conventional windows which uses reflective surface coatings with dead air spaces between layers to reduce heat transfer. Awarded $50 707.

Richard P. Gingras, President, Dynamic Electric Control, Inc., Connecticut
A home thermostat incorporating a computer to assure optimum and automatic "set back" control. Awarded $65 000.

Walter Hasselman, Jr., C.P. Chemical Co., Inc., New York
A rigid insulating board made of phenol methylol urea foam. Tests show good flame resistance, low toxicity fumes and good thermal conductivity properties. The material could be made from coal rather than oil. Awarded $29 900.

Donald J. Verley, Piranha Products Company, California
A water-powered device to replace conventional food waste disposal units which are powered by electric motors. Awarded $28 000.

Ronald H. Smith, President, Solergy, Inc., California
A reflective-type solar collector designed to achieve greater efficiency at higher temperatures without seasonal or daily adjustments. Awarded $46 884.

Harry Woods, Louisiana
A direct contact, gas-fired hot water heater that can extract the latent heat of the water vapor formed during combustion. Awarded $72 600.

Seymour Jarmul, New York
A device to store energy in fused salts in an insulated box at the point of use. Awarded $20 740.

MOTOR VEHICLES

Paul Schweitzer, Pennsylvania
An electronic spark timing control for vehicle engines, which automatically finds the best economy timing consistent with emission requirements and freedom from engine knock. Awarded $88 895.

George C. Austin, Jr., Austin Tool Co., California
A system for converting a standard gasoline engine into a diesel engine. Awarded $18 000.

Robert Cameron, Scotsman Automotive Corp., Illinois
An accessory screen for internal combustion engine carburetors to improve atomization for better fuel economy. Awarded $74 579.

William H. Cone, Iowa
A prime mover engine for a refrigerator truck which is modified to function as an A.C. generator as well as being an engine. Electricity produced powers sealed refrigerator on trailer, replacing present diesel-powered refrigeration unit. Awarded $50 000.

R. K. Bose, Virginia
A device which utilizes a high speed turbine to refine exhaust gases and recirculate the unburned portions of that gas to the engine. Awarded $40 000.

John J. and Albert B. Csonka, FERRO Technical Company, New York
A new kind of carburetor which is claimed to be fuel-saving and pollution-reducing. Awarded $193 500.

COMMERCIAL

Robert J. Jones, California
Waste heat utilization for commercial cooking equipment which recovers some of the energy in such a way as to avoid interaction with grease vapors. Awarded $65,000.

Robert M. Arthur, President, Arthur Brothers Co., Inc., Wisconsin
A device to reduce power consumption of waste water treatment plants by matching oxygen supply to demand of aerobic micro-organisms. Awarded $58,200.

Leon Lazare, The Puraq Company, Connecticut
A new type of absorption refrigerator with increased cycle efficiency. Awarded $75 000.

Robert S. Norris, R. S. Norris & Associates, New York
A utilization technology to embody waste automotive lubricating oils into a fuel additive. Awarded $50 000.

Drew W. Morris, Drew-it-Corp., New Hampshire
A portable trailer-mounted device for crushing cans and bottles thereby increasing the density of the scrap, making handling more efficient. Awarded $35 000.

POWER GENERATION

David W. Doyle, InterTechnology Corp., Virginia
The use of reverse osmosis to produce a high pressure liquid that can subsequntly be passed through a hydraulic turbine to produce electric power. Awarded $48 950.

D. J. Schneider, Texas
A wind-activated power generating system intended to provide large power outputs in regions where the prevailing wind direction does not vary appreciably during the day. Awarded $50 000.

Sidney A. Parker, Texas
A new kind of power plant cycle using low grade, low temperature energy which does not need copious amounts of water for its operation. Awarded $40 000.

Alvin Marks, Marks Polarized Corp., New York
A device to convert thermal energy to electric energy without the use of moving parts. Awarded $50 000.

Joseph Yater, Massachusetts
A concept for a solid state device claimed to transfer thermal energy into usable electrical power with high efficiency, by cascading large numbers of such circuits. Awarded $40 400.

AGRICULTURAL

John Bruce, South Dakota
A new method of drying grains such as corn, rice, and soybeans by alternately exposing the commodities to dry, hated air and to vacuum. Awarded $52, 917.

J. W. Fowler, North Caroline
An energy-efficient means of drying agricultural products using heat regeneration or salvage, solar collection and improved insulation. Awarded $54 980.

NBS PUBLISHES UPDATED SURVEY OF STATE SOLAR ENERGY LEGISLATION

by Mat Heyman

State governments have substantially stepped-up their level of activity in passing legislation relating to solar energy applications in buildings, according to a survey conducted by the National Bureau of Standards.

During 1977 alone, 33 states passed 72 separate bills dealing with solar energy use in buildings. This compares to 44 bills passed in 1976 and just 34 bills signed into law over the 1974-5 period. By the close of 1977, a total of 40 states had adopted one or more solar-related legislative proposals.

The NBS survey, *State Solar Energy Legislation of 1977: A Review of Statutes Relating to Buildings*, was undertaken by the NBS Center for Building Technology with funding from the Department of Energy and the Department of Housing and Urban Development. A major purpose of the report is to make comprehensive and detailed information about specific state legislation and implementing documents available to those states which are still fashioning or refining their own legislation.

The bills enacted into law had the common goal of encouraging the early acceptance and use of solar devices to provide water heating and space heating and cooling for buildings. Legislation covered in the NBS survey includes statutes providing for: property, income, and sales tax incentives; standards, certification, and codes; easements; loans; research, development, and demonstration efforts; and improved information for the public.

The Bureau's report provides abstracts of laws, legal citations, and the names of responsible state agencies and officials. In most cases, the full text of laws are included in appendices, along with supporting forms and documents. A chart pinpointing state solar laws enacted from 1974-77—with a break-down by state and by type of law—is also provided.

Single copies of the 395-page *State Solar Legislation of 1977: A Review of Statutes Relating to Buildings* (NBSIR 79-1705) are available while supplies last from: Robert Eisenhard, B226 Building Research Building, National Bureau of Standards, Washington, D.C. 20234. The report will also be available for sale through the National Technical Information Service, Springfield, Virginia 22151.

Heyman is a writer and public information specialist in the NBS Public Information Division.

STATE ACTS RELATING TO SOLAR ENERGY 1974–77	TAX INCENTIVES			EASEMENTS & ZONING	STANDARDS AND/OR CERTIFICATION	CODE PROVISIONS	PROVIDE STATE PROMOTION, INVESTIGATION OR R&D	STATE BUILDINGS TO USE SOLAR	LIFE CYCLE COST ANALYSES AND FEASIBILITY OF NON-FOSSIL FUEL IN STATE OWNED/ASSISTED BUILDINGS	SOLAR LOANS	UTILITIES & SOLAR
	REAL PROPERTY	INCOME	SALES								
Alabama											
Alaska		○							●		
Arizona	●	●	○				●				
Arkansas		○					○				○
California	○ †	●			○	●	●	○	○		●
Colorado	●	○		●			●		●		
Connecticut	●		○		●						
Delaware											
Florida					●	●	●		●		
Georgia	●		●				●				
Hawaii	●	●					●		○		○
Idaho		●									
Illinois	●						○		○		○
Indiana	●										
Iowa							●	○			
Kansas	○	●		○					○		
Kentucky							●				
Louisiana											
Maine	○		○				●				
Maryland	●			○			●				
Massachusetts	●	●							●	○	
Michigan	●		●				●				
Minnesota					●				○	○	
Mississippi											
Missouri											
Montana	●	○					●				
Nebraska									○		
Nevada	○						●				
New Hampshire	●										
New Jersey	○				○						
New Mexico		●		○	○		●		●		
New York	○				○		●				
North Carolina	○	○					●		●		
North Dakota	●	○		○							
Ohio							●				
Oklahoma		○							○		○
Oregon	●	○		●	○		○ †			○	
Pennsylvania											
Rhode Island	○						●				
South Carolina											
South Dakota	●										
Tennessee											
Texas	○	●	●				○		○		
Utah							○				
Vermont	●										
Virginia	●				○		●				
Washington	○				●		●		●		
West Virginia											
Wisconsin		○			○						
Wyoming											
Totals	27	17	6	6	11	2	25	2	15	3	5

● 1974–1976 LEGISLATION
○ 1977 LEGISLATION
† NOT APPROVED BY VOTERS

Source: State Solar Energy Legislation of 1977: A Review of Statutes Relating to Buildings, *by Robert M. Eisenhard and Laura A. Santucci, National Bureau of Standards.*

Publication sponsored by the Department of Energy and Department of Housing and Urban Development.

Raman Microprobe, page 22
Radioactivity, page 24
Precision Power and Energy, page 25

CHARACTERIZING SOUTH POLE AEROSOLS WITH THE RAMAN MICROPROBE

*The Raman microprobe developed at the National Bureau of Standards has recently been used to study atmospheric aerosol samples collected at the South Pole. (An aerosol is a suspension of microscopic particles in a gas.) The purpose of this research, being conducted jointly with the University of Maryland with support from the National Science Foundation, is to help in understanding the relative extent to which major, manmade particulate sources contribute to the global aerosol covering. The project relates to the general concern over whether it would be possible for man to alter the earth's climate by injecting excessive amounts of particulate matter into the atmosphere.**

William C. Cunningham and W. Zoller, University of Maryland, and Edgar S. Etz, NBS Center for Analytical Chemistry, Building A121, 301/921-2872.

The Raman microprobe has proved to be an effective tool for identifying single particles in airborne dust samples. Its ability to identify specific sulfates as major constituents of aerosol samples has been demonstrated for various types of aerosol collections. In the work reported here, we have employed the NBS Raman microprobe to obtain vibrational spectra from single microparticles and subnanogram amounts of submicrometer aerosol particles collected from the atmosphere at the South Pole. The remoteness and isloation of this area from any major particle source make this an ideal location to study composition and concentrations of the global particulate burden typical of the upper troposphere or lower stratosphere.*

The results of the microprobe analysis give direct evidence for the existence of sulfate species in the South Pole aerosol, but further studies are needed to clarify many remaining questions concerning the *in situ* nature of the aerosol. Foremost are questions pertaining to sampling effects, the likely reactions of atmospheric sulfate aerosol with other aerosol components and the collection substrate, as well as chemical transformations that may have occurred during sample storage and handling.

Molecular Analysis in the Raman Microprobe

Raman microprobe analysis furnishes spectra characteristic of the molecular and crystal vibrations of the sample. Spectra are obtained by analyzing the inelastically scattered light from the sample probed by a beam of focused laser light. The microprobe is basically a Raman spectrometer consisting of an exciting laser, beam focusing and scattered light collection optics, a sample stage, a monochromator, and a photo-multiplier detector. The sample stage is enclosed by a sample chamber purged with dry nitrogen to prevent exposure of hygroscopic samples to ambient conditions of high relative humidity.

The laser excitation wavelength that is most often used is 514.5 nm (green). However, when appreciable absorption or sample fluorescence is encountered at this wavelength, the spectrum is excited with 647.1 nm (red) radiation. Both excitation wavelengths were used for the analysis of South Pole aerosol. Irradiance levels from several kilowatts/cm^2 to fractions of a megawatt/cm^2 were employed by varying the beam spot size between 20-2 μm diameter. The size of the laser spot in the focal region roughly determines the spatial resolution with which the microprobe measurement is made. Measurement times necessary to obtain analytical quality spectra may vary from tens of minutes to several hours depend-

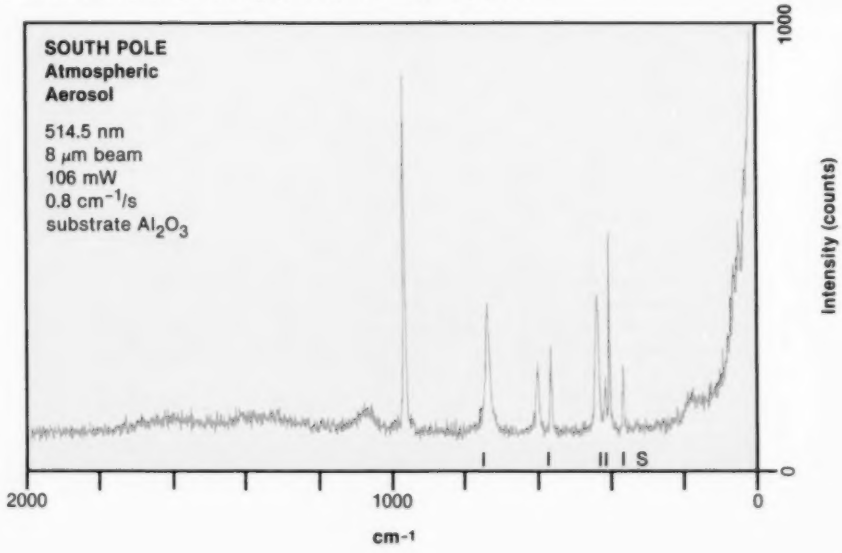


Figure 1—*Raman microprobe spectrum of impractor-collected (sapphire substrate) South Pole atmospheric aerosol. Indicated are laser excitation wavelength, size (diameter) of laser spot, laser power (at sample), scan rate, and sample support. Measurement time constant is 1.3/s; spectral slit width is 3 cm^{-1}.*

*A more detailed, annotated discussion of this research will soon be published by the University of Maryland and NBS researchers. (Contact Dr. Etz.) This and related work will be presented in a Ph.D. dissertation by Cunningham.

*The stratosphere is low enough in this location to permit aerosol collection from ground level.

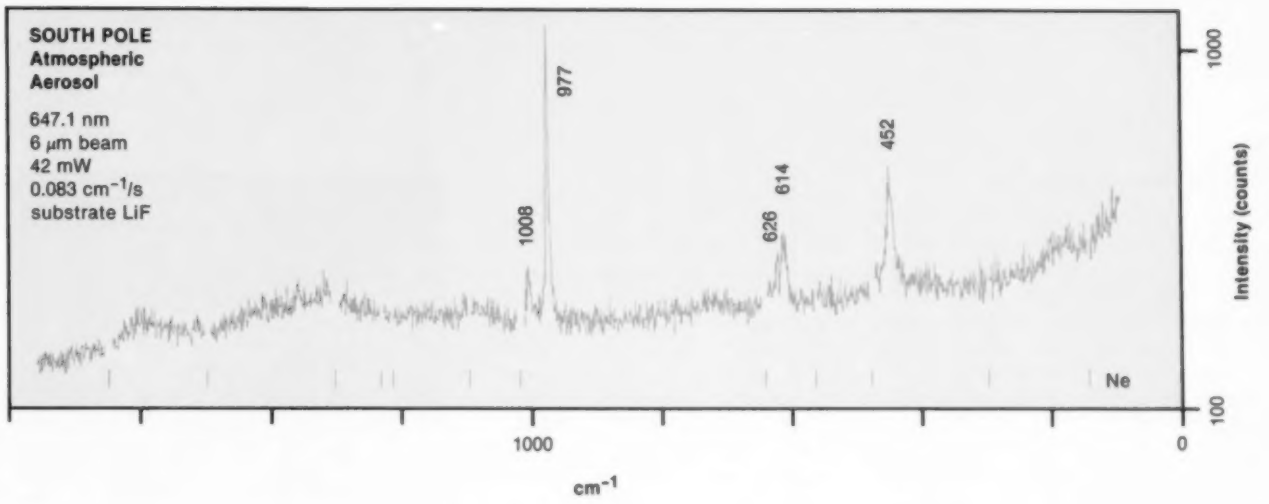


Figure 2—*Raman microprobe spectrum of South Pole aerosol collected on a lithium fluoride substrate. Measurement conditions are indicated. Scan time constant is 10 s; spectral slit width is 3 cm^{-1}. Vertical bars below recording indicate frequency positions of neon calibration lines.*

ing upon the detected scattering intensity.

The relative humidity within the sample chamber can be held to ~20 percent to protect hygroscopic samples. The samples are, however, exposed to ambient laboratory air during transfer to the spectrometer sample stage and during observation in the light microscope. A number of the South Pole particulate samples have inadvertently been exposed to relative humidities high enough for moisture absorption to have taken place. In these cases, microscopic droplets were seen to have formed and coalesced with ones nearby forming larger microdroplets. Raman microprobe measurements have been made on particles formed by the recrystallization of such droplets when samples were returned to low relative humidity conditions.

Figure 1 is a Raman spectrum obtained from a recrystallized particle. The particle was one of numerous particulates found on the fifth stage of an air sampler of the impactor type that segregated the airborne particles according to size. A sapphire substrate was used in the sampling of this aerosol for microprobe analysis. Examination of the positions, intensities, and shapes of the observed Raman bands indicates that the microcrystal principally consists of ammonium sulphate, $(NH_4)_2SO_4$. The bands arising from SO_4^{2-} vibrations in this molecular solid are seen centered at frequencies 452, 614, 977, and 1080 cm^{-1}. Relative to the band intensities observed for the SO_4^{2-} vibrations, the bands due to the internal vibrations of the NH_4^+ ion are not detected in this measurement because of their comparatively much weaker scattering intensity. When detected, these bands are broad and have shifts centered at 1429 and 1669 cm^{-1}. The weak, broad features centered at 1350 cm^{-1} and 1600 cm^{-1} are indicative of carbonaceous material associated with the particle. The origin of this material is unknown but the appearance of "carbon bands" in the spectra of environmentally collected samples is not uncommon. The bands centered at 187 cm^{-1} and 73 cm^{-1} arise from lattice vibrations and are characteristics of the crystal structure of the solid phase. The bands marked "S" arise from the sapphire substrate. Morphological and chemical analysis in the scanning electron microscope (SEM) analysis shows this particle to be flat, with rounded edges, containing sulfur as the only observable element.

In other field samplings of the South Pole aerosol, lithium fluoride (LiF)—rather than sapphire (α-Al_2O_3)—substrates were used as impaction plates. Examination of these collections in the SEM revealed two distinguishable morphologies which could be related by Raman microprobe measurements to two chemically different microcry-stalline solids. Figure 2 is the spectrum obtained from a microscopic sample region of the aerosol deposit on a LiF substrate. In this measurement, the probing laser beam was directed at a group of microparticles displaying the two distinct morphologies. Here as well, the spectrum indicates $(NH_4)_2SO_4$ to be the predominant constituent, however, a second component is detected by the presence in the spectrum of the band at 1008 cm^{-1}. This feature (together with other weaker bands) is characteristic of lithium sulfate, Li_2SO_4, as was verified by measurements of laboratory-prepared microparticle samples of the pure salt. From these observations, it appears that a sulfate component (e.g., H_2SO_4, HSO_4) of the atmospheric aerosol has undergone a chemical transformation in the sampling process, as evidenced by its section with the LiF substrate resulting in Li_2SO_4. This is reasonable, for lithium fluoride is a reactive material, whereas sapphire is not. Definitive identification of the two principal components of the microsample was made by frequency or band position assignments relative to neon calibration lines omitted (in this case) from the spectrum but indicated by the vertical bars labeled Ne. Analysis of other aerosol collections on LiF subtrates showed Li_2SO_4 to be associated with $(NH_4)_2SO_4$ to varying degrees. Some spectra even showed an essentially pure hydrated phase of Li_2SO_4. Various questions related to potential sample modifications remain (for example, the origin of NH_4^+ in these samples) and further work on the more conclusive interpretation of these spectra is in progress.

turn page

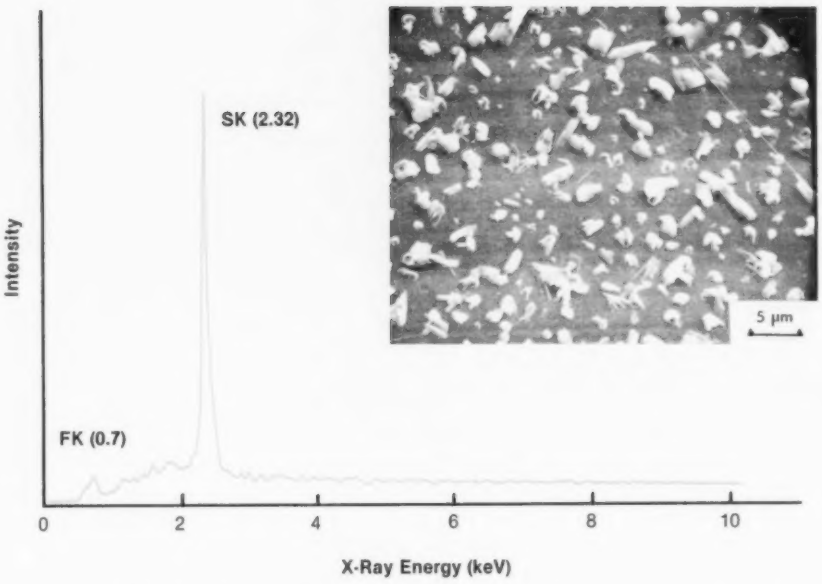
Figure 3—*SEM micrograph of South Pole aerosol collected on a lithicum fluoride substrate.*

Figure 4—*X-ray spectrum obtained with the SEM of an aggregate of microparticles in sample of South Pole atmospheric aerosol (cf. Figure 3).*

Elemental Analysis in the SEM

The results of micro-Raman analysis have been correlated with measurements made with the scanning electron microscope (SEM) which was equipped for elemental microanalysis, using an energy dispersive x-ray detector. Sample regions investigated in the Raman microprobe were relocated in the SEM. Characteristic particle morphologies could be distinquished and x-ray measurements were made on numerous single particles and aggregate of aerosol particles. Figure 3 shows a typical region of a collection of South Pole aerosol impacted on a LiF substrate. This sample area of microscopic dimensions contains individual particles of different sizes and shapes as well as aggregates. X-ray analysis shows sulfur to be the only element detected in these particles (the lighter elements, such as nitrogen and oxygen, are not detected in the instrument and does not permit the specific chemical (ie., molecular) form of the element(s) to be determined. An x-ray spectrum representative of those obtained from microparticles of all identifiable, distinct morphologies is presented in Figure 4. This particular scan is from one of the aggregates seen in Figure 3. Two x-ray peaks are noted. The strong peak (at energy 2.32 keV) arises from the $K\alpha_1\beta$ emission of the sulfur present in the micro-sample, whereas the much weaker peak (at 0.7 keV) is attributed to the $K\alpha$ emission of fluorine in the LiF substrate.

This study—among others like it—illustrates the complementary nature of the two microanalytical techniques. The Raman microprobe now provides a new capability for the speciation of elements not possessed by the more conventional electron beam methods.



UNITS OF MEASUREMENT FOR RADIOACTIVITY

The growing interest in radioactivity and radiological protection makes timely the publication of the following Table that shows the interrelationship of the units of measurement used in those fields.

Louis Barbrow, Office of Weights and Measures, Room A211, Metrology Building, 301/921-2401.

The *becquerel* is the activity of a radionuclide decaying at the rate of one spontaneous nuclear transition per second. The *gray* is the absorbed dose when the energy per unit mass imparted to matter by ionizing radiation is one joule per kilogram. NOTE—The *gray* is also used for the ionizing radiation quantities: specific energy imparted, kerma, and absorbed dose index, all of which have the SI unit joule per kilogram.

The *sievert* is the dose equivalent when the absorbed dose of ionizing radiation multiplied by the dimensionless factors Q (quality factor and N (product of any other multiplying factors) stipulated by the International Commission on Radiological Protection is one joule per kilokilogram.

The coulomb per kilogram is the exposure when x or gamma rays produce in free air one coulomb of electrical charge per kilogram of dry air.

QUANTITY	UNIT				
	SI		Customary		
	Name	Symbol	Name	Symbol	Value in SI units
activity (of a radionuclide)	becquerel	Bq	curie	Ci	1 Ci = 3.7 x 10^{10} Bq
absorbed dose	gray	Gy	rad	rad	1 rad = 10^{-2} Gy
dose equivalent	sievert	Sv	rem	rem	1 rem = 10^{-2} Sv
exposure (x and gamma rays)	coulomb per kilogram	C/kg	roentgen	R	1 R = 2.58 x 10^{-4} C/kg

PRECISION POWER AND ENERGY MEASUREMENTS

The National Bureau of Standards has the basic responsibility for establishing the electrical units for the Nation and making them available to science and industry through calibrations and other services. This requires high-level research in physics and engineering, development of new measurement techniques and refinement of existing ones to meet new needs, design and construction of special instrumentation and standards and of comparators for calibrating the basic standards of other laboratories, calibrations of such high-level standards, and other services related to these tasks. The users of these services, from utilities companies to other government agencies, federal and private laboratories, and corporations, large and small, have the opportunity to interact directly with NBS staff at workshops, seminars, and conferences sponsored by the Bureau. These meetings are held to keep NBS clients informed of measurement state-of-the-art and available services and to identify new needs as they arise within the user community. One such seminar, called Power and Energy Measurement, was held last April. The following report presented at that meeting gives an overview of an important area of NBS concern—electric power metering at 60 Hertz. Metering at this level affect every home and business. The accuracy of both the wattmeters used for such metering and the watthour meters with which they are calibrated is of growing economic importance.*

F. L. Hermach (retired) Electrical Measurements and Standards Division. For further information, contact Rita McAuliff, B344 Metrology Building, 301/921-3121.

Methods of Calibrating Watthour Meters

Electrical power metering at 60 Hz is the final result of a long series or chain of measurements at NBS. These measurements and the standards and instruments calibrated by NBS gain much of their economic importance from the necessity for accurate metering. Standard watthour meters are normally calibrated to 0.05 percent, and requests for even better accuracy can be met. Wattmeters can be calibrated to 0.01 percent or better. At these levels it is especially important to understand the basis for accurate power and energy measurements, to make the best use of the NBS standards and services.

The energy supplied at the terminals of a 2-wire circuit for a time t is $W = \int_0^t vi\ dt = \int_0^t pdt$ (eq. 1), where v, i, and p are the instantaneous voltage, current, and power. Over one cycle of an ac applied voltage of period T the average power is $P = \frac{1}{T}\int_0^T p\ dt$ (eq. 2). If the average power is constant for the time t, $W = Pt$ (eq. 3). Strictly, t must equal mT where m is a whole number, but this is not necessary in calibrations—see following paragraphs. If, in addition, the voltage and current waves are sinusoidal, with rms values of V, and I, W—tVIcosθ (eq. 4).

These simple fundamental relationships are very useful in classifying and evaluating methods and standards for calibrating standard watthour meters (rotating standards). A calibration consists, of course, of determining the percentage registration $R = \frac{100kn}{W}$ (eq. 5), where k is the disc constant in watthours per revolution, n is the number of turns and W is the true energy in watthours.

Watthour meters are integrating devices. Thus, the energy, W, should ideally be measured by an integrating standard which obeys equation 1, and which "sees" or responds to the same power as the meter under test for the same time interval. We shall call this method A. The acuracy is then (to the first order) independent of small fluctuations in voltage and current and of small deviations from sinusoidal waveforms.

Another standard watthour meter could be used for method A, but eventually it must be calibrated by other means. Calorimetric methods, in which the electrical energy is measured by the heat it produces, could be used, but they are not sufficiently accurate. (Indeed, the best calorimeters are calibrated electrically.) Instead electrodynamic wattmeters, which respond to the average power, P, are widely used. The power is held constant by manual or automatic means. Such wattmeters have been highly developed, and modern 60-Hz power supplies can have very small voltage fluctuations, making this method B (following equation 2) practical. By separately energizing the voltage and current circuits, only the power losses in the meters need be supplied, instead of the much larger indicated power.

In the last decade or so other types of wattmeters have been developed and some are now commercially available. The grave deficiencies of early thermocouple wattmeters have been overcome by very ingenious electronic circuits. Wattmeters with electronic multipliers, such as time-division and other pulse-area circuits, have been very successful.

By electromagnetic feedback, a dc voltage proportional to the average power can be obtained from an electrodynamic instrument. With a voltage-to-frequency converter and a cycle counter, an output proportional to energy (method A) can be realized.

It would be quite impracticable to simultaneously measure the 4 quantities of equation 4 with high accuracy. However this method C has been very successfully used in a current comparator circuit which makes the measured power proportional to the square of the voltage across a resistor. Again, modern power supplies with high stability and excellent waveform make this method feasible.

These newer developments will be described in more detail by other seminar speakers. All of these methods, new and old, are designed to measure the true energy (W in equation 5). However, since the true value is unknown and unknowable, what is needed with each of them is a reliable estimate of the limits of the difference between the measured energy

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*An upcoming issue of DIMENSIONS will report further on the activities of this seminar.

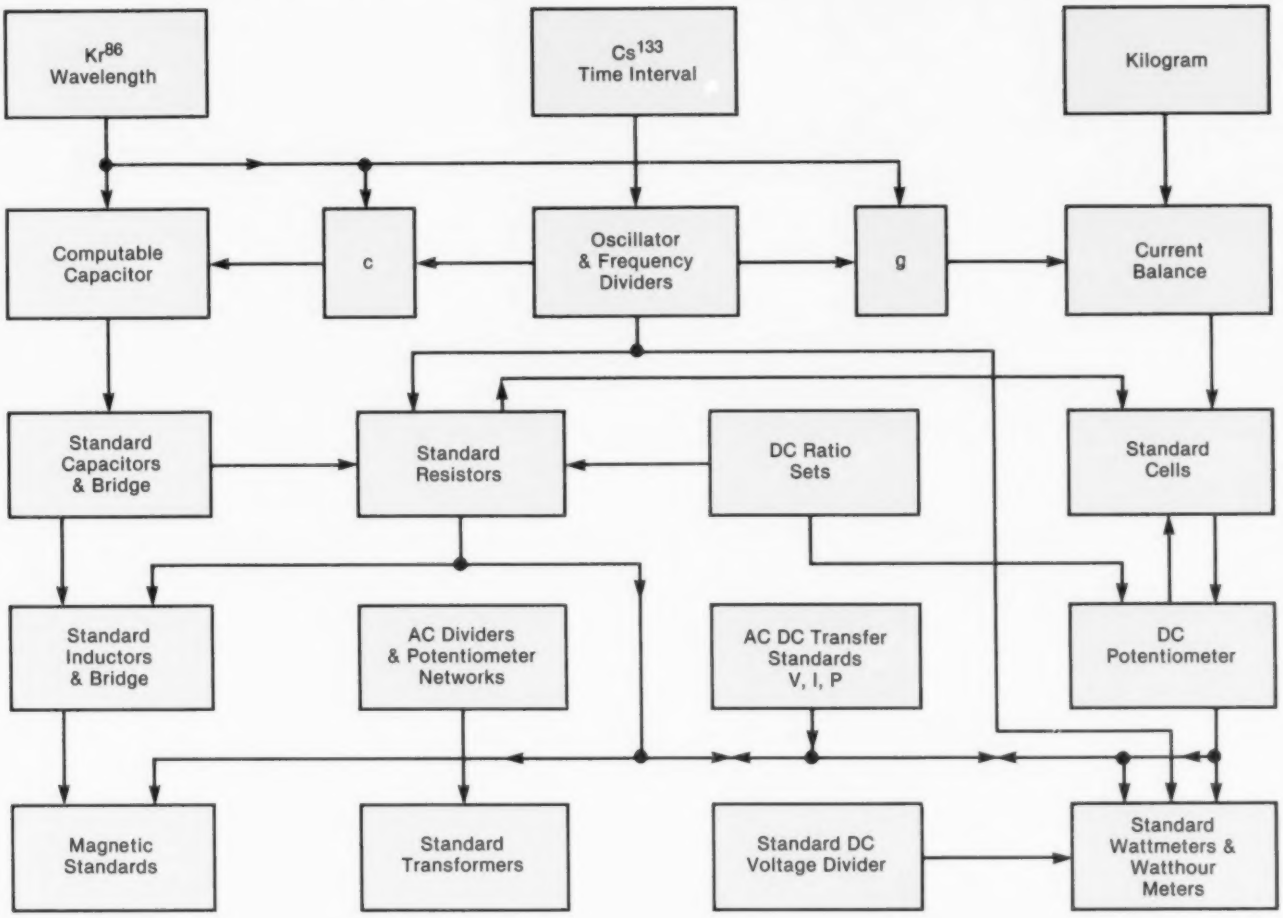

Figure 1—*Major electrical standards used by NBS in calibration program.*

and the true value. The NBS standards and the NBS calibration and other services can be of great value in determining this.

NBS Standards

Figure 1 shows the major electrical standards which are used by NBS in its calibration program. The lines indicate the major relationships among them. For clarity, some minor relationships and the kinds of calibration performed are now known.

The internationally-accepted prototype standards of mass, length, and time are shown in the top row of the figure. The meter is now defined as a certain number of wavelengths of the orange-red line of krypton 86 and the meter bar is a reference, rather than a prototype, standard. The atomic second is now defined in terms of a specified transition of cesium 133, and stable oscillators serve as working standards of frequency (Hz). The kilogram is still defined as the mass of the prototype Pt-Ir standard.

Two experiments are performed at NBS to determine the basic electrical units in terms of these three standards and two measured constants, the speed of light in vacuo (c) and the acceleration of gravity (g). They are reasonably simple in principal but extremely difficult and involved in practice because of the accuracy required. One experiment consists in constructing a capacitor and computing its capacitance in electromagnetic units (about 1 pF) from its length and the speed of light. With remarkable bridges the step up is made at 1592 Hz to two

1000-pF capacitors ($X_c = 100\ 000\ \Omega$) across to two 100,000-Ω resistors down to 1000-Ω resistors of known ac-dc difference, and then down to 1-Ω resistors. The final step is taken because 1-Ω Thomas-type resistors are still the most stable impedance standards known. The average resistance of a group of such resistors serves to maintain the ohm at NBS between such absolute determinations.

The other experiment consists in "weighing the ampere" with a current balance, and is thus based directly on the definition of the ampere in terms of the force between current-carrying conductors. One conductor (coil) is suspended from one arm of a balance, and the change in force when its current is reversed is measured in terms of the acceleration of gravity on a known mass. The voltage drop in a 1-Ω standard resistor carrying this measured direct current is then used to determine the emf of a group of saturated standard cells.

The volt was formerly maintained at NBS by such a group of cells. Now, however, a dc voltage can be maintained with much better precision and stability in terms of a measured frequency by means of the ac Josephson effect. The NBS cells are now monitored frequently, and corrections are made for any changes in their emfs.

At NBS the ohm is believed to be accurate (known in terms of the defined "absolute" value) to better than 0.1 ppm. The ampere and the volt are believed to be accurate to better than 5 ppm, but the volt is maintained (thanks to the Josephson apparatus) with a precision and stability of better than 0.05 ppm.

Direct-reading ratio-sets were developed at NBS to calibrate resistors by the substitution method, and to step up and down on the resistance scale. No line leads to them in Figure 1 because their accuracy depends on ratios of resistors or turns on a current comparator, not on the unit of resistance. Standard cells are calibrated by connecting the known and unknown cells in opposition and measuring the small voltage difference with a low-range thermofree potentiometer. Potentiometers and volt boxes are calibrated with universal and direct-reading ratio-sets. With these the user can then extend the dc voltage scale very accurately.

AC-DC transfer instruments are comparators for determining the equality of ac and dc currents, ac and dc voltages, and ac and dc powers. At NBS they serve chiefly to determine how well other ac-dc comparators do this. Since such comparators are very stable, the user can then make accurate ac measurements based on this known dc standards.

For many years an electrodynamic wattmeter was the basic ac-dc transfer standard for ac power and energy measurements at NBS, and it was used to calibrate the NBS reference group of standard watthour meters periodically. Now, however, a thermocouple transfer voltmeter coupled with a current comparator serves the same functions, and a thermocouple wattmeter is used for ac calibrations of other wattmeters.

Chains of Measurements in the Meter Laboratory

All of the links shown in the NBS chains of measurements are necessary to derive the watthour in a meter laboratory. However, not all of them need be carried out at NBS. Many laboratories start with a group of standard cells and resistors and carry out the succeeding links themselves with their own wattmeters, because of the capabilities and flexibility this gives them.

An ac-dc wattmeter serves two important functions. It (a) embodies in the one instrument a standard of power, and (b) transfers the measurement from dc to ac. Most of the sources of error in the instrument do not affect the ac-dc difference (frequency response), so that ordinarily the determination of its ac-dc difference need be made only once, and subsequent tests can be made (much more simply) with direct current. Unfortunately some electronic wattmeters (and the induction watthour meter, too, of course) cannot be calibrated on dc, so this valuable separation of errors cannot be realized.

Other meter laboratories maintain groups of standard watthour meters, since these determine the commercially-important unit of energy directly and simply. They then send one or more meters to NBS or an independent laboratory for periodic tests. Here it is important to be sure that differences in the test and use conditions do not cause significant changes. The influences of such variables as temperature, humidity, applied voltage and frequency, etc., must be known, and the ranges of these variables must be given.

NBS Services

NBS calibrates the standards shown in the blocks of Figure 1. NBS also now provides a Measurement Assurance Program (MAP), in which NBS watthour meters are calibrated as "standard samples" in the meter laboratory with the user's equipment, and the results are evaluated with NBS help. These calibration and MAP services will be described by other speakers.

Interlaboratory "round robin" tests provide valuable additional assurance against unsuspected systematic errors. NBS can help set up and evaluate such tests. NBS uses them too. An international comparison of 60 Hz power measurements was completed recently, with agreement to better than 30 ppm.

A very useful technique to help insure sustained accuracy is the purposeful periodic testing (without adjustment) of "check standards," in this case a few house-type watthour meters like those under calibration at the final stations of the meter shop. Plotting the percentage registrations of these meters vs time leads to control charts by which otherwise unsuspected changes in the production line can be detected. The check standards are calibrated (less often) in the meter laboratory. The NBS Statistical Engineering Laboratory and its publications can be very helpful in fully utilizing this technique. □

CONFERENCES

For general information on NBS conferences, contact JoAnn Lorden, NBS Public Information Division, Washington, D.C. 20234, 301/921-2721.

NBS FIRE RESEARCH ANNUAL CONFERENCE

Reports of recent progress in fire research and a discussion of future needs and plans will be highlighted at the Annual Conference on Fire Research at the National Bureau of Standards, August 22-24, 1979.

Sponsored by the NBS Center for Fire Research, the annual meeting provides an opportunity for the Center's grantees and contractors to meet with NBS staff and other members of the fire research community. Currently, about 30 universities and research groups have been carrying out studies in fire science and engineering through the Center's Office of Extramural Fire Research. This work supplements the Center's own in-house research program.

This year's conference will feature research on the chemistry and physics of fire. Topics to be discussed will include fuel pyrolysis, ignition, flame spread, steady burning, extinction, fire retardance, flame inhibition, smoke formation and properties, and fire modeling. Anyone with an active interest in the fire research field is invited to attend.

For further information write: Office of Extramural Fire Research, Center for Fire Research, B260 Polymers Building, National Bureau of Standards, Washington, D.C. 20234.

BUILDING REGULATORY RESEARCH, INNOVATION CONFERENCE

The Fourth Annual Joint Conference on Research and Innovation in the Building Regulatory Process, will be held on September 11, 1979, in St. Louis, Missouri. Jointly sponsored by the National Bureau of Standards and the National Conference of States on Building Codes and Standards, Inc. (NCSBCS), the meeting is taking place in conjunction with the NCSBCS annual conference at the Chase Park Plaza Hotel.

The following or related subject areas will be discussed.

- Legal, economic, social, political, and technical bases of building regulation.
- Evaluation or assessment of management and procedures of regulatory agencies.
- Procedures for better communications with architects, engineers, and contractors.
- Implementation of energy conservation building standards.
- Activities relating to the consensus standards development process.
- Analysis of building regulation effects.
- Studies of planning, policy, or political action aimed at building and construction regulations.
- Relation of building regulation to other forms of development controls.
- Regulatory research needs of building officials.
- Measurement of the economic impact of research on building standards and codes.
- Successes and failures with computers and microfilm in building code enforcement and functions.
- Codes and standards development for building rehabilitation.
- Implications of new issues and concerns affecting the built environment such as physical security, solar energy, seismic risk, metrication and dimensional coordination.
- Water conservation and the regulatory interface.
- Impact of Federal actions on the building regulatory process.

For further information contact: Sandra A. Berry, B226 Building Research Building, 301/921-3146.

WINTER SIMULATION CONFERENCE

The 1979 Winter Simulation Conference (WSC 79), will be held December 3-5 1979, in San Diego, California.

Cosponsoring WSC 79 are the National Bureau of Standards and six leading organizations sharing an interest in computer simulation. Simulation—defined as a tool or technique involving the use of computers to synthesize and analyze models of real world problems—will be discussed at sessions targeted for managers, users, practitioners, researchers, and newcomers to simulation.

The 1979 conference will feature papers and panel discussions on discrete and combined (discrete/continuous) simulations. It will be organized into tutorial, application, and methodology sessions. Papers are expected to cover a broad range of topic areas including:

Simulation Methodology

Experimental design, Language developments, Statistical analysis, Debugging aids, Validation techniques, Human interfaces, Education and training, and Random number generation.

Simulation Applications

Information systems, Database systems, Computer systems, Planning models, Scheduling, Logistics and networks, Reliability control, Financial models, Communications, Agriculture and forestry, Energy, Health, Industry, Government, Transportation, Education, and Military.

Cosponsoring WSC 79 with NBS are the American Institute of Industrial Engineers; the Association for Computing Machinery's Special Interest Group on Simulation; the Systems, Man, and Cybernetics Society of the Institute of Electrical and Electronics Engineers (IEEE); the Operations Research Society of America (ORSA): the College of Simulation and

Gaming of The Institute for Management Sciences (TIMS); and the Society for Computer Simulation.

For further information contact: Paul Roth, B250 Technology Building, 301/921-3545.

CONFERENCE CALENDAR

June 21

18TH ANNUAL ACM TECHNICAL SYMPOSIUM, NBS, Gaithersburg, MD; sponsored by NBS and ACM; contact: Seymour Jeffery, A257 Technology Building, 301/921-3531.

June 25

MINORITY BUSINESS MEETING, NBS, Gaithersburg, MD; sponsored by NBS and NOAA; contact: Keith Chandler, Supply Building, 301/921-2969.

July 22-27

NATIONAL CONFERENCE ON WEIGHTS AND MEASURES, Red Lion Motor Inn, Portland, Oregon; sponsored by NBS and NCWM; contact: Harold Wollin, A211 Metrology Building, 301/921-2677.

August 13-15

SIMULATION, MANAGEMENT AND MODELING OF COMPUTER SYSTEMS, NBS, Gaithersburg, MD; sponsored by NBS; contact: Paul Roth, B250 Technology Building, 301/921-3545.

September 5-7

SYMPOSIUM ON EDDY CURRENT NONDESTRUCTIVE TESTING, NBS, Gaithersburg, MD; sponsored by NBS, ASTM and ASNT; contact: George Birnbaum, A363 Materials Building, 301/921-3331.

*September 18-21

IMPACT OF IMPROVED CLOCKS AND OSCILLATORS ON COMMUNICATION AND NAVIGATION SYSTEMS WORKSHOP; Gaithersburg, MD; sponsored by the Air Force Office of Scientific Research with the Cooperation of NBS; contact: S. Stein, NBS Boulder, 303/499-1000, ext. 3277.

*September 25-26

NATIONAL CONFERENCE ON LABORATORY EVALUATION; NBS, Gaithersburg, MD; sponsored by NBS; contact: G. Berman, 301/921-2427.

October 9-11

FOURTH ANNUAL CONFERENCE ON MATERIALS FOR COAL CONVERSION AND UTILIZATION, NBS, Gaithersburg, MD; sponsored by NBS and DOE; contact: Samuel Schneider, B308 Materials Building, 301/921-2893.

*October 23-26

JOINT CONFERENCE ON MEASUREMENT AND STANDARDS FOR RECYCLED OIL/SYSTEMS PERFORMANCE AND DURABILITY, NBS, Gaithersburg, MD; sponsored by NBS, MFPG, ASTM Technical Division P on Recycled Petroleum Products and Lubricants; contact: Donald Becker, B50 Physics Building, 301/921-2621, or Harry Burnett, B264 Materials Building, 301/921-2812.

December 3-5

1979 WINTER SIMULATION CONFERENCE, San Diego, California; sponsored by NBS, AIIE, ACM, IEEE, ORSA, TIMS, AND SCS; contact: Paul Roth, B250 Technology, 301/921-3545.

* *New Listings*

PUBLICATIONS

NATIONWIDE SURVEY OF COBALT-60 TELETHERAPY DOSIMETRY

Nationwide Survey of Cobalt-60 Teletherapy Dosimetry, *Soares, C. G., and Ehrlich, M., Nat. Bur. Stand. (U.S.), Tech. Note 978, 40 pages (August 1978) Stock No. 003-003-01968-2, $1.60.**

This publication reports on the methods and results of a special study of cobalt-60 teletherapy units in the United States conducted by the National Bureau of Standards in cooperation with the Bureau of Radiological Health.

Between September, 1974, and December, 1977, approximately two-thirds of the cobalt-60 teletherapy units were surveyed by mail using a rugged thermoluminescence dosimetry system to determine the accuracy with which a prescribed dose of gamma radiation is delivered to a specified point in a water phantom.

The dose given by participants was evaluated from dosimeter response, and information supplied by participants was used to check their computations of the dose delivered. In this nationwide study, 83 percent of the units surveyed yielded dose interpretations within 5 percent of the requested dose, 13 percent yielded differences between 5 and 10 percent, and 4 percent of the dose interpretations differed by more than 10 percent from the dose requested. The text discusses the survey design in some detail, considers sources of the dose discrepancies, and compares the results of this survey to those of other dosimetry surveys.

** Publications cited from this point on may be purchased at the listed price from the U.S. Government Printing Office, Washington, D.C. 20402 (foreign: add 25%). Microfiche copies are available from the National Technical Information Service, Springfield, VA 22161. For more complete periodic listings of all scientific papers and articles produced by NBS staff, write: Editor, Publications Newsletter, Administration Building, National Bureau of Standards, Washington, D.C. 20234.*

LX39 LATENT FINGERPRINT MATCHER

The LX39 Latent Fingerprint Matcher, Wegstein, J. H., and Rafferty, J. F., Nat. Bur. Stand. (U.S.), Spec. Publ. 500-36, 78 pages (August 1978) Stock No. 003-003-01958-5, $1.10.

A procedure is described for automatically determining if a latent scene-of-crime fingerprint matches an inked, rolled file fingerprint. The procedure uses the x and y coordinates and the individual directions of the minutiae (ridge endings and bifurcations). The identity of the latent print with a print on file is indicated by a high score resulting from computations based on differences in angle and coordinate values of minutiae that are found in going from one of the fingerprints to the other.

Sponsored by: Federal Bureau of Investigation, J. Edgar Hoover Bldg., Washington, D.C. 20535.

SEMICONDUCTOR MEASUREMENT TECHNOLOGY

Semiconductor Measurement Technology: Angular Sensitivity of Controlled Implanted Doping Profiles, Wilson, R. D., Dunlop, H. H., Jamba, D.M., Huges Research Laboratories, and Meyers, D. R., Nat. Bur. Stand. (U. S.), Spec. Publ. 400-49, 61 pages (November 1978), Stock No. 003-003-01997, $2.50.

Ion implantation, in which an ion beam is directed at a wafer of single crystal silicon, can be used to produce accurately controlled deposits of dopants in the wafer for the construction of semiconductor devices and integrated circuits. One important consideration in controlling the implantation is "channeling," the phenomenon in which ions are steered down the axial lattice channels of the crystal by collisions with the ordered arrangement of the substrate atoms.

This text discusses the angle at which the ion beam must strike the substrate in order to maintain control over the distribution of channeled ions—either to maximize or minimize this effect. Unlike most previous studies, the present work considers a range of atomic number and energy representative of most laboratory implantation today.

A method to calculate the classical critical angle for channeling is presented, and data are given that characterize the variation in depth distribution of carriers with substrate orientation, incident in species, and incident ion energy, for this range of critical values.

This study establishes the degree of control of the angle betwen the beam and the crystallographic orientation needed to produce the limiting cases of either optimal channeling (for buried layers of dopant) or maximum randomization of ion trajectory in the substrate.

AIR AND WATER POLLUTION

Air and Water Pollution—Annual Report, FY 74-76, Kirchhoff, W. H., and Myers, E., Nat. Bur. Stand. (U.S.), Tech, Note 963, 387 pages (October 1978) Stock No. 003-003-09183-6, $6.00.

This report contains a project-by-project description of progress and accomplishments in the National Bureau of Standards programs in air and water measurement covering fiscal years 1974 to 1976.

Measurement of the concentration and the chemical and physical properties of substances in air and water provides an understanding of the extent and effects of pollution. The objective of the NBS programs in air and water measurement is to provide the basis for determining the accuracy of air and water measurements and for achieving greater accuracy. This is accomplished through the development of improved measurement methods, the development of measurement standards, and the provision of accurate technical information.

The projects covered in this report deal specifically with:

Air—

- Research leading to development of SRM's (Standard Reference Materials) or other means for ensuring the accuracy of air measurement methods.
- Development of laboratory methods with improved accuracy, sensitivity, and specificity for air pollution measurements.
- Generation, evaluation, compilation, and dissemination of data and technical information needed to relate the substances emitted from sources of pollution to those found in the atmosphere after chemical reactions have occurred.

Water—

- Evaluation of the accuracy of methods for measuring water velocity and flow in open and closed channels.
- Development of radioactivity standards.
- Development of Standard Reference Materials for evaluating the accuracy of instruments and methods for measuring the concentration of pollutants in water and sediments.
- Measurement evaluation and compilation of physical and chemical properties of known pollutants.

SPACE FLIGHT IN MATERIALS SCIENCE AND TECHNOLOGY

Applications of Space Flight in Materials and Technology, Silverman, S., and Passaglia, E., Nat. Bur. Stand. (U.S.), Spec. Publ. 520, 128 pages (September 1978) Stock No. 003-003-01973-9, $3.

The proceedings of the April 1977 Conference on the Applications of Space to Materials Science and Technology review the materials science experiments carried out in space and assess the possible future applications of space shuttle. Experiments carried out on Skylab, the Apollo-Soyuz Test Project, and recent sounding rocket experiments are described. Specific discussions directed at possible future applications in metals and alloys, ceramics, semiconductor materials, biological materials, crystal growth, transport properties, combustion, and convection effects are also included.

Sponsored by: National Bureau of Standards and NASA, Washington, D.C. 20546.

Measurement Science and Technology Policy and State-of-the-Art Surveys

Bennett, L. H., Kruger, J., Parker, R. L., Passaglia, E., Reimann, C., Ruff, A. W., and Yakowitz, H., Economic Effects of Metallic Corrosion in the United States. Part I. A Report to the Congress by the National Bureau of Standards, Nat. Bur. Stand. (U.S.), Spec. Publ. 511-1, 65 pages (May 1978) Stock No. 003-003-01926-7, $2.30.

Payer, J. H., Dippold, D. G., Boyd, W. K., Berry, W. E., Brooman, E. W., Buhr, A. R., and Fisher, W. H., Economic Effects of Metallic Corrosion in the United States—Appendix B. Part II. A Report to NBS by Battelle Columbus Laboratories, Nat. Bur. Stand. (U.S.), Spec. Publ. 511-2, 249 pages (May 1978) Stock No. 003-003-01927-5, $4.25.

Peiser, H. S., and Birch, J. A., Eds., Standardization in Support of Development. Proceedings of a Seminar held at the National Bureau of Standards, Gaithersburg, MD, Oct. 17-18, 1977, Nat. Bur. Stand. (U.S.), Spec. Publ. 507, 163 pages (May 1978) Stock No. 003-003-01928-3, $3.50.

Nuclear Physics and Radiation Technology

Duvall, K. C., Meier, M. M., Wasson, O. A., and Huynh, V. D., Neutron Flux Intercomparison at NBS, J. Res. Nat. Bur. Stand. (U.S.), *83*, No. 555-561 (Nov.-Dec. 1978).

Fuller, E. G., and Gerstenberg, H. M., Photonuclear Data Index, 1973-1977, Nat. Bur. Stand. (U.S.), Spec. Publ. 380, Suppl. 1, 102 pages (Aug. 1978) Stock No. 003-003-01967-4, $2.75.

Properties of Materials: Electronic, Magnetic, and Optical

Chang, T., Foster, D., and Kahn, A. H., An Intensity Standard for Electron Paramagnetic Resonance Using Chromium-Doped Corundum ($Al_2O_3:Cr^{3+}$), J. Res. Nat. Bur. Stand. (U.S.), *83*, No. 2, 133-164 (Mar.-Apr. 1978).

Properties of Materials: Thermodynamics and Chemical Kinetics

Han, C. C., Serdyuk, I. N., and Yu, H., Diffusion Coefficients of the 45S and 50S States of the Large Ribosomal Subnit of E. Coli by Quasielastic Light Scattering, J. Res. Nat. Bur. Stand. (U.S.), *84*, No. 1, 1-8 (Jan.-Feb. 1979).

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Buxton, G. V., and Sellers, R. M., Compilation of Rate Constants for the Reactions of Metal Ions in Unusual Valency States, Nat. Bur. Stand. Ref. Data Ser., Nat. Bur. Stand. (N.S.), 62, 78 pages (June 1978) Stock No. 003-003-01882-1, $2.40.

Corliss, C., and Sugar, J., Energy Levels of Titanium, Ti I through Ti XXII, J. Phys. Chem. Ref. Data *8*, No. 1, 1-62 (1979).

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Hubbell, J. H., and Overbo, Relativistic Atomic Form Factors and Photon Coherent Scattering Cross Sections, J. Phys. Chem. Ref. Data *8*, No. 1, 69-106 (1979).

Janz, G. J., Tomkins, R. P. T., and Allen, C. B., Molten Salts: Volume 4, Part 4. Mixed Halide Melts, J. Phys. Chem. Data *8*, No. 1, 125-302 (1979).

Martin, W. C., Zalubas, R., Hagan, L., Atomic Energy Levels—The Rare-Earth Elements. The Spectra of Lanthanum, Cerium, Praseodymium, Neodymium, Promethium, Samarium, Europium, Gadolinium, Terbium, Dysprosium, Holmium, Erbium, Thulium, Ytterbium, and Lutetium, Nat. Stand. Ref. Data Ser., Nat. Bur. Stand. (U.S.), 60, 422 pages (April 1978) Stock No. 003-003-01712-4, $9.50.

Odintzova, G. A., and Striganov, A. R., The Spectrum and Energy Levels of the Neutral Atom of Boron (Bi), J. Phys. Chem. Ref. Data *8*, No. 1, 63-68 (1979).

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Roder, H. M., The Molar Volume (Density) of Solid Oxygen in Equilibrium with Vapor, J. Phys. Chem. Ref. Data *7*, No. 3, 949-958 (1978).

Shaw, R., Semi-Empirical Extrapolation and Estimation of Rate Constants for Abstraction of H from Methane by H, O, HO, and O2, J. Phys. Chem. Ref. Data *7*, No. 3, 1179-1190 (1978).

Standard Reference Materials

Velapoldi, R. A., Paule, R. C., Schaffer, R., Mandel, J., and Moody, J. R., Standard Reference Materials: A Reference Method for the Determination of Sodium in Serum, Nat. Bur. Stand. (U.S.), Spec. Publ. 260-60, 106 pages (Aug. 1978) Stock No. 003-003-01978-0, $3.00.

Verdier, P. H., Wagner, H. L., The Characterization of Linear Polyethylene SRM's 1482, 1483, and 1484. I. Introduction, J. Res. Nat. Bur. Stand. (U.S.), *83*, No. 2, 169-177 (Mar.-Apr. 1978).

NEWS BRIEFS

COMPUTER INSTITUTE HAS NEW DIRECTOR. James H. Burrows has been appointed director of the NBS Institute for Computer Sciences and Technology. His appointment took effect on May 14. For most of the past decade, Burrows has been the top civilian official responsible for overseeing the Air Force's data processing support program.

OFF BY AN ORDER OF MAGNITUDE. Last month DIMENSIONS was somewhat modest in reporting the capability provided by an NBS magnification standard for scanning electron microscopes. The standard (SRM 484a) is for use in calibrating a magnification scale to an accuracy, said DIMENSIONS, of within 55 percent or better. Actually, the achievable accuracy is within 5 percent or better. Order from the NBS Office of Standard Reference Materials, B311 Chemistry Building, Wash., D.C. 20234. Price: $247.

FIRE RESEARCH GRANTS. The NBS Center for Fire Research recently awarded three grants to: Y. Alarie, University of Pittsburgh, to study toxicity of plastic combustion products; M. Drews, Clemson University, to study antimony oxide-organohalogen-polymer substrate interactions in the solid phase; and B. Zinn, Georgia Institute of Technology, to investigate smoke formation by polymeric materials, smoke reduction methods, and chemical characterization of smoke particles.

CALL FOR PAPERS. Papers are being solicited for presentation at the December 1979 Annual Computer Networking Symposium sponsored by the IEEE and NBS. Papers of a tutorial nature are being sought which describe practical experiences with computer networks and network applications, or which present new research results over a wide range of topics. Abstracts of 1000 words are due July 15. For details call or write Fran Nielsen of the NBS Institute for Computer Sciences and Technology, B212 Technology Building, Wash., D.C. 20234, 301/921-2601.

WEIGHTS AND MEASURES CONFERENCE. The 64th National Conference on Weights and Measures will meet in Portland, OR, from July 22 to 27, 1979. The annual meeting of State and local metrology officials will take up such consumer items as the use of metric units for gasoline pumps and for standard grocery store commodities, and the proper measurement of the "net weight" of items subject to moisture loss.

NEXT MONTH IN

DIMENSIONS/NBS

Einstein's theories have their practical applications. Read about relativity and a new satellite system in the next issue of DIMENSIONS/NBS.

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Courtesy Department of Housing and Urban Development pages 2-6.

The Commerce Department's National Bureau of Standards was established by Congress in 1901 to advance the Nation's science and technology and to promote their application for public benefit. NBS research projects and technical services are carried out by the National Measurement Laboratory, the National Engineering Laboratory, and the Institute for Computer Sciences and Technology. Manufacturing, commerce, science, government, and education are principal beneficiaries of NBS work in the fields of scientific research, test method developments, and standards writing. DIMENSIONS/NBS describes the work of NBS and related issues and activities in areas of national concern such as energy conservation, fire safety, computer applications, materials utilization, and consumer product safety and performance. The views expressed by authors do not necessarily reflect policy of the National Bureau of Standards or the Department of Commerce.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Annual subscription: Domestic, $11.00, foreign, $13.75. Single copy: Domestic, $1.10, foreign, $1.40. The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through June 30, 1981.

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